UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/932,236	08/16/2001	Haining Yang	MI22-1725	4828

21567 7590 07/13/2004

WELLS ST. JOHN P.S.
601 W. FIRST AVENUE, SUITE 1300
SPOKANE, WA 99201

EXAMINER	
HOGANS, DAVID L	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 07/13/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/932,236	YANG, HAINING	
	Examiner	Art Unit	
	David L. Hogans	2813	

-- The MAILING DATE of this communication appears on th cover sheet with th correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 June 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *55-69* is/are pending in the application.

4a) Of the above claim(s) *66-69* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *55-65* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *16 August 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7-14-03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the Request for Continued Examination filed on June 18, 2004.

Election/Restrictions

1. Newly submitted claims 66-69 are directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

Species I – appears to relate to Claims 66-69 (noting that Species I does not require the formation of a barrier layer and that the metallo-organic precursor must be comprised by carbon and one or more of Co, Pd and Ni)

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 66-69 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Status of Claims

Claims 55-65 are pending. Claims 66-69 are withdrawn. Claims 1-54 are cancelled.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on June 18, 2004, which is a copy of the IDS submitted on July 14, 2003, is in compliance with the provisions of 37 CFR 1.97, and accordingly, has been considered by the examiner.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 55-59 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. For instance, the specification fails to make mention of forming "the second conductive material physically against the first conductive material without an insulative composition between the first and second conductive materials." The specification at page 4 paragraph [0015] makes mention of forming the second conductive material physically against the first conductive material but does not mention that an insulative material is absent from this composition.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 55 and 60-64 are rejected under 35 U.S.C. 102(b) as being anticipated by 5,130,172 to hicks et al.

In reference to Claim 55, Hicks et al. teaches:

- providing a semiconductor substrate; (See columns 3-8 lines 20-40)
- forming a first conductive material over the substrate, the first conductive material comprising one or more of TiN, WN, TaN, elemental Ta, elemental Ti and elemental W; (See columns 3-8 lines 20-40 – noting column 6) and
- depositing a second conductive material physically against the first conductive material, the second conductive material consisting essentially of a metal and being different than the first conductive material, wherein the depositing comprises: (See columns 3-8 lines 20-40 – noting column 6)
- providing a metallo-organic precursor proximate the first conductive material, wherein the metallo-organic precursor comprises the metal and carbon; (See columns 3-8 lines 20-40) and
- exposing the precursor to a reducing atmosphere (hydrogen) to release the metal from the precursor to form the second conductive material physically against the first conductive material without an insulative composition between the first and second conductive materials (See columns 3-8 lines 20-40)

In reference to Claim 60, Hicks et al. teaches:

- providing a semiconductor substrate having tungsten-comprising layer thereover; (See columns 3-8 lines 20-40)
- exposing one or more metallo-organic precursors to a reducing atmosphere to release metal from at least one of said precursors; (See columns 3-8 lines 20-40) and
- depositing the released metal over the tungsten-comprising layer to form a conductive material on the tungsten-comprising layer (See columns 3-8 lines 20-40)

In reference to Claim 61, Hicks et al. teaches:

- wherein the tungsten-comprising layer comprises an upper surface of elemental tungsten (See columns 3-8 lines 20-40)

In reference to Claim 62, Hicks et al. teaches:

- wherein the conductive material is formed physically against the upper surface (See columns 3-8 lines 20-40)

In reference to Claim 63, Hicks et al. teaches:

- wherein the one or more precursors comprise one or more of ruthenium, rhodium, iridium, cobalt, palladium, and nickel (See columns 3-8 lines 20-40)

In reference to Claim 64, Hicks et al. teaches:

- wherein tricarbonyl-cyclohexadiene ruthenium (noting L_nMR_m wherein L=cyclohexadienyl, M=ruthenium, R=CO, n= 0 to 3 and m= 0 to 3) is comprised by said one or more precursors (See columns 3-8 lines 20-40)

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 55-59 are rejected under 35 U.S.C. 103(a) as being unpatentable over 6,074,945 to Vaartstra et al. (hereinafter Vaartstra '945) in view of 6,197,628 to Vaartstra et al. (hereinafter Vaartstra '628)

Claim 55

Vaartstra '945 teaches providing a semiconductor substrate; forming a first conductive material over the substrate, the first conductive material comprising one or more of TiN, WN, TaN, elemental Ta, elemental Ti and elemental W (noting column 6 lines 5-25); and depositing a second conductive material consisting essentially of a metal and being different than the first conductive material, wherein the depositing comprises: providing a metallo-organic precursor proximate the first conductive material, wherein the metallo-organic precursor comprises the metal and carbon; and exposing the precursor to a reducing atmosphere to release the metal from the

precursor to form the second conductive material. (See Figure 1 and columns 1-6 lines 40-60)

Vaartstra '945 fails to explicitly teach wherein the second conductive material is formed physically against the first conductive material without an insulative composition between the first and second conductive materials.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches wherein a second conductive material is formed physically against the first conductive material without an insulative composition between the first and second conductive materials.

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating a second conductive material formed physically against a first conductive material without an insulative composition between the first and second conductive materials, as taught by Vaartstra '628, to provide an electrical connection to a substrate that prevents the migration of silicon into the metallic layers, thereby preventing destruction of the contact.

Claim 56

Incorporating all arguments of Claim 55 and noting that Vaartstra '945, in column 3 lines 55-65, teaches forming an insulative layer over the substrate, wherein the insulative material comprises sidewalls defining an opening extending to the substrate

in at least one cross-section, but Vaartstra '945 fails to explicitly teach wherein forming the first conductive material comprises forming the first conductive material within the opening.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches wherein forming the first conductive material (285) comprises forming the first conductive material within the opening (259).

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating forming the first conductive material within the opening, as taught by Vaartstra '628, to provide a diffusion barrier for prevention of silicon migration, which can cause destruction of the contact.

Claim 57

Incorporating all arguments of Claims 55 and 56 and noting that Vaartstra '945 fails to explicitly teach etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches etching the second conductive material into a rectangular block, wherein the block comprises a

sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section.

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section, as taught by Vaartstra '628, to provide for local and global planarization, which improves the quality of follow-on-process steps, such as lithography.

Claim 58

Incorporating all arguments of Claims 55 and 56 and noting that Vaartstra '945 fails to explicitly teach etching the second conductive material into a rectangular block, wherein the sidewalls of the block are aligned vertically over the opening in at least the one cross-section.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches etching the second conductive material into a rectangular block, wherein the sidewalls of the block are aligned vertically over the opening in at least the one cross-section.

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating etching the second conductive material into a rectangular block,

wherein the sidewalls of the block are aligned vertically over the opening in at least the one cross-section, as taught by Vaartstra '628, to provide for a continuous contact between the plug and the walls of the via, thereby preventing void formation and possible shorting of the interconnect.

The Examiner notes that Merriam-Webster's Collegiate Dictionary (2001), Tenth Edition, defines over as "above". As per Applicant's language, the sidewalls must only be aligned vertically above the opening. "The opening" can be any portion of the entirety of the opening. Therefore, a portion in the opening near the substrate, would have a block with a sidewall above it. Vaartstra '628 teaches sidewalls of a block that are aligned and vertical and that are above the substrate.

Claim 59

Incorporating all arguments of Claim 55 and noting that Vaartstra '945 teaches wherein the metallo-organic precursor consists essentially of tricarbonyl-cyclohexadiene ruthenium; the reducing atmosphere consists essentially of ammonia; and the second conductive material having a thickness of about 800 A (noting that deposition rates can be 100 A/min).

Although Vaartstra '945 does not teach a second conductive layer with a thickness of 450 A, it would have been obvious to one having ordinary skill in the art at the time the invention was made to optimize the deposited layers thickness, as the goal

of device electronics is to become smaller, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (CCPA 1955)

Finally, the specification contains no disclosure of either the critical nature of the claimed process (i.e. – the second conductive layer having a thickness of 450 A) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

9. Claim 65 is rejected under 35 U.S.C. 103(a) as being unpatentable over 5,130,172 to Hicks et al. in view of 6,074,945 to Vaartstra et al.

Incorporating all arguments of Claim 60 and noting that Hicks et al. fails to explicitly teach wherein the reducing atmosphere comprises ammonia. The Examiner notes that Hicks et al., in column 5 lines 62-68, teaches that hydrogen is preferred but other reducing gases may be used.

However, Vaartstra et al., in column 3 lines 40-50, teaches wherein the reducing atmosphere is comprised by ammonia.

It would have been obvious to one of ordinary skill in the art to modify Hicks et al. by incorporating a reducing atmosphere comprised by ammonia, as taught by Vaartstra et al., to provide a reactive complex that is favorably deposited on the substrate, and to additionally regulate the uniformity of deposition across the substrate.

Response to Arguments

10. Applicant's arguments with respect to claims 55-65 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David L. Hogans whose telephone number is (571) 272-1691. The examiner can normally be reached on M-F (7:30-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DH

CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800